Relevant Economic Variables for Analyzing the Impacts of Natural Resource Development on Rural Communities

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Relevant Economic Variables for Analyzing the Impacts of Natural Resource Developments on Rural Communities*

This paper outlines some of the key economic variables for analyzing the impacts of natural resource developments on rural communities. The first section covers definitional issues. A conceptual basis useful in this analysis is briefly reviewed in the second section. In the final section we present some views on empirical issues in growth impact analysis.

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Definitional Issues

In order to define the scope of the discussion we start with definitions for the terms community, rural, development, natural resource development, and impacts.

Community

The term community can take on several meanings. It may refer to geographic areas, governmental units, or interest groups. A community may have spatially separated geographic areas but active social and economic interaction. For example, a bedroom community is part of a larger functional economic area.

Within a given spatial area there may be functionally separate groups with overlapping membership. Governmental units such as the county, municipalities, and school districts are examples of this. Industrial sectors such as farming, manufacturing, construction, retail and wholesale each share common sectional interests and may be considered as separate communities. Likewise, socio-economic-groups and special interest groups have community characteristics.

For the purposes of analysis, specific boundaries need to be drawn. We advocate the identification of several communities based on the nature of the impacts of the development and the decision makers involved. If a particular homogenous group of individuals expects the project to have significant impacts on it, this group ought to considered as one of the "communities." This implies that we look at the impacts separately for

the school district, county and city and also separate out the impacts for large earners, small business proprietors, farmers, fixed income persons, homeowners, and renters.[1]

It also implies that we not attempt to aggregate the benefits and costs for the entire community, where community is defined in a geographical fashion or as a governmental unit. Usually there are trade-offs between the groups at the local level and aggregating across groups requires knowledge of a social welfare function. The articulation of such a welfare function is the legitimate job of politicans, clergy, crusaders, and local leaders but not of analysts.

Rural communities are abritarily defined as non-metropolitan areas or those outside an SMSA.

Development

Development may imply growth or movement toward a set of desired goals. Or it may simply refer to a change in the use of a community's natural, humar or capital resources. In this paper we use the second definition. Note that use of the second definition means that this change or development might be considered positive by some impacted groups or communities but negative by others,

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[1] For more detailed discussions on this see, Nelson.

While development of natural resources usually implies a new commercial use, our definition would be consistent with policies to preserve natural resources for future use.

Natural resources are required for nearly all types of development. Energy, industrial, residential and commercial development all require land and other natural resources. Partially for this reason and partially because we see little difference in the overall research framework needed for these types of development, we include everything under the natural resource umbrella.

Impacts

Impacts are defined as the consequences of the development. They may leave either positive or negative valuations and the valuation of a given impact may differ with the group involved. For example, an increase in apartment rents due to growth is seen positively by landlords and negatively by tenants. These pecuniary impacts are frequently not considered since they are local transfers and do not add nor subtract from the communities total wealth. This view implicitly assumes that the distribution of wealth is not important. We suggest that the political support or opposition to many natural resource developments depends as much on the distributional or pecuniary impacts, as on the real impacts.

Impacts must be defined as the level of achievement of a given goal, say incomes per capita, with the proposed development compared to the level of achievement without the development. This is conceptually

easy to understand but frequently empirically difficult to handle. Analysts frequently use a before-after comparison rather than the correct with-without approach. Both yield identical results if there are no underlying socio-economic changes occuring in the area without the development. But since this is seldom the case, attention must be given to this issue.[2]

A Conceptual Basis for Development Impact Assessment

Consistent with the with-without perspective, we view the community of interest as existing in some static or dynamic base state. This state is defined by the interrelationships which link the component parts to one and another and to the "rest of the world." These linkages are both direct and indirect, and they may be either static or dynamic in a temporal context. At least in an economic context, it may also be useful to distinguish between backward and forward linkages.

Direct linkages will not exist between many pairs of entities within the community, but almost all pairs will be indirectly linked as a result of the network of direct linkages to common entities. For instance, consider two industries in the local economy, A and B. Neither supplies inputs to or uses products from the other, and so there are no direct linkages between them. Now consider a third sector C which uses output from B to produce inputs for A. A change in the level of activity in A directly effects

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[2] For a discussion of this issue see, Morse, 1979.

C and, in turn, indirectly effects B. A and B are thus indirectly linked in spite of not being directly linked. In a similar manner, direct links are augmented by additional indirect links. Often, the direct and indirect linkages are aggregated and represented as a multiplier. An initial change in (say) employment in any one sector triggers additional employment in many other sectors. The ratio of the initial to the total new employment is the employment multiplier. Value added, income, or sales multipliers can be similarly defined.

Static linkages may exist relating activity in one area to many activities which must occur simultaneously. Production of variable inputs is essentially of this nature, including both direct and indirect linkages. Dynamic linkages may be either lagged or leading. Lagged linkages exist when activity in one period influences the state of the community in subsequent periods. For instance, current economic activity influences current income distribution, which may influence political power relationships only in the future. Leading linkages exist when (anticipated) activity in some future period influences the state of the community in the present. Capacity expansion and real estate speculation are examples.

Backward linkages exist when one activity requires that some other activity occur. In an economic context direct and indirect input requirements are backward linkages from a producing activity to its suppliers (both direct and indirect). "Non-economic" areas may be backward linked to economic activity. For instance, direct and indirect environmental linkages have been

estimated using input-output models. Forward linkages exist when one activity allows some other activity to occur. For instance, a producing sector is forward linked to its customers, to whom it is a source of supply enabling their own production.

The introduction of any development into the community may be viewed as triggering impacts through the network of linkages. Since we are interested in economic development, and our concern here is ultimately with variables relevant to the economic impacts, we'll begin with the linkages between the development and the economy. Backward linkages will be formed between the new development and its direct and indirect input suppliers. These backward linkages will not alter linkages between existing economic sectors.

Forward linkages will be formed if the development becomes a supplier of existing firms. In this event, linkages between pairs of existing firms may be altered. The development may eliminate previously existing bottlenecks allowing substitution to locally produced goods and services from imports. It may also cause substitution away from existing local goods in favor of the development's output. The development may create the potential for local production of previously imported goods or services, creating additional new backward and forward linkages.

The forward and backward linkages of the development with the rest of the economy will vary over time both by nature of leading and lagged

linkages and by the nature of the time distribution of development related activity (i. e., construction, growth, stabilization and decline).

Impacts on the market economy have traditionally been viewed in this manner in conceptual models of general dynamic interdependence of economic sectors. Empirical models are much harder to specify than broad conceptual models, but much empirical effort has been put forth by economists in this area. Attention has been focused on business sector, labor force and public sector fiscal impacts. Focusing on linkages as the mechanism through which impacts are transmitted seems fruitful in these areas.

Economists have used this linkage approach to specify direct and indirect backward linkages from economic sectors to the environment based on input-output models.[3] We can see, from our perspective as an economists, social and political linkages which may or may not have empirically potential. Perhaps they have already been considered and abandoned in Sociology and Political Science, but we'll very cautiously suggest them in order to generate some interdisciplinary discussion. Political and social participation or alienation would seem to be backward linked to the economy through the labor force by the distribution and level of income. They may be forward linked to the economy through political regulations, taxes, etc. and through labor productivity as influenced by absenteeism and job alienation. We need to examine this area more closely.

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[3] The first empirical development of these concepts was the input-output table for the American economy developed by Wassilf Leontief.

At any rate, from an economists perspective, focusing on linkages is a useful conceptual basis from which to view economic impacts, and the approach suggests important theoretical considerations from which we may focus in on the relevant variables issue at hand.[4] We need to identify the direct and indirect impacts of development activity, the time distribution of those impacts, and the time distribution of the development activity triggering the impacts. We should focus on variables which are relevant in this respect.

Estimation Issues

The definitional and conceptual issues suggest several empirical estimation issues that need special attention. These relate to the goals of the group or communities undergoing development, private sector impacts; and the linkages between sectors and public sector estimation problems.

Community Goals

The choice of the relevant variables and relevant impacts on which to focus attention depends on the goals of the community or impacted groups and on the constraints on their actions. What does each group hope will be achieved as the development proceeds? Or what problems do they hope to avoid? What are the physical, biological, social, economic or legal constraints on their choices?

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4 Lin and Yotopoulos describe linkage analysis based on input-output models and their role in development planning in more depth.

Economic goals of resource development may include: (1) increases in total area income, (2) increases in employment, (3) reduction in poverty, (4) increases in per capita incomes, (5) higher rates of return on capital and wage rates, (6) minimization of cyclical swings and unstability in the economy, (7) expansion of the tax ease, (8) favorable fiscal impact on local government and taxpayers. Several of these are similar and overlapping but none are identical. And occasionally there are trade-offs between these goals.

The relevance of each type of impact depends on the weight which the decision-makers put on each of these goals or on other social goals. Obviously this may vary depending on both the local setting and the participants in the decision process.

It is hard to imagine a sizeable development or even a small scale one requiring public assistance for which public officials and taxpayers are not interested in the fiscal impacts on local government.

Since trade-offs may exist between public sector losses and private sector gains information is usually needed on the private sector impacts. The exact manner of defining goals depends on how communities are defined. As analysts we should simply be asking: Who will be affected? What do they want to know? And we should be willing to accept the fact that the relevant impacts may vary from case to case.

Private Sector Benefits

Income benefits of development programs are defined in several ways. Clayton defined them as the payroll going to employees within the municipality or other geographic areas being studied. Morse and Hushak define primary income benefits as the increase in incomes to local workers as a result of the development. Shaffer and Tweeten's definition includes the increased income from all sources spent in the community. [5]

As we described earlier development impacts on income have both direct or primary effects and indirect or secondary effects. Income and employment multipliers measure the secondary impacts. For example an employment multiplier of 1.7 means for every 100 new jobs in the development, there are 70 additional jobs in related industries or service sectors. Obviously the value of the multiplier makes a tremendous difference on the total impact.

The types of linkages in a local economy affect the size of local income and employment multipliers. For example, firms with few or no forward or backward linkages within the local economy will have very low multipliers and vice versa. We'd expect a firm importing all of its raw materials and selling its products outside the region (to one with low linkage) to have little multiplier effect. But ones using a lot of local raw materials of locally supplied products (i.e., high backward linkage) to have high multiplier due to the higher linkage.

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[5] See Hushak for more of these differences.

An implication of this is that industrial plants attracted to a small county are likely to have lower multipliers than ones in larger metropolitan areas.

Multipliers can be estimated using input-output models, export base analysis, or econometric techniques. Each approach has its advantages and disadvantages. The choice of the most appropriate technique depends on the objectives of the study and the time and resources available to do the analysis. While input-output is the most sophisticated approach and allows the greatest detail in results, it is also expensive and time consuming. Non-survey or limited survey techniques are still subject to testing and some reports suggest considerable error in these non-survey I-O models. The report base approach may provide a good compromise between cost and accuracy for small communities with a medium to small scale development.[6]

The scale of development will influence the necessity of allowing wages and factor prices to change. The size of the development relative to the local labor market is the key variable. If the development is large relative to the labor market wages are likely to be bid upwards. The ramifications of this may need to be traced out for other local labor, local businesses, renters on fixed incomes, or other groups.

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[6] See Shaffer for a review of these alternatives. Empirical models use both the input-output and the export base approach. For an example of each type, see Leistrity and Morse and Gerard respectively.

Public Sector Estimation Problems

While the vast majority of the economic effects occur in the private sector, much of the debate about impacts occurs about the public sector impacts.

A number of estimation problems arise in these sectors, largely due to the lack of output measures for publicity provided services. The intangible services such as education, police and fire protection present more problems than water, sewer and garbage collection. This lack of an output measure makes the estimation of changes in public expenditures much more difficult than estimating changes in revenues.

Attention needs to also be focused on the institutional arrangements of the tax structure and state aid. However, careful attention to detail allows these institutions to be accurately modeled.

Economies of scale, excess capacity, effectiveness of inducements, predicting the residential location of labor and the time frame are key problems in estimating the changes in expenditures.

Changes in public expenditures have been estimated using six basic approaches: (1) department official estimates, (2) expenditure per capita multipliers, (3) community service standards, (4) cross-sectional analysis, (5) expenditures in comparable cities and (6) economic engineering analysis. The most commonly used is the per capita multiplier,[7] but it ignores economies of scale and excess capacity. The most accurate approach

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7 Burchell and Listokin, pp. 25-44.

is some form of economic engineering.[8] However, it also requires the most time to impliment.

Excess capacity presents special problems for expenditure estimation. Burchell and Listokin recommend the case study approach, i.e., asking local officials to estimate these changes. To empirically determine the level of excess capacity they recommend asking local officials to identify the "desired" level of service. The amount by which the current level exceeds the desired level is the amount of excess capacity. If there is no excess capacity then officials are asked to indicate their expected reaction to accommodate the development.

Judging the accuracy of public officials' response is the major problem with this approach. Political budgetary concerns can easily become part of the considerations. In Ohio we have found both under and over estimation by local officials, depending on their political aggressiveness.[9]

The residential location of new employees and their families is a key factor in determining public sector impacts. It appears difficult to predict with any confidence the number of employees which will come from the local area versus in-migrants versus commuters.[10] Additional research is needed to determine the validity of gravity models since this variable is so important.

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8 For a good example of this see Doeksen.

9 Morse, 1979.

10 Smith

The time pattern of growth is an important variable in assessing the impacts of development. Boom and bust developed patterns put more strain on public services and their financing than slow sustained growth.[11] Tax revenues may lag behind public sector expenditures in the early stages of growth even if they balance out over the entire period. Tax laws in Ohio freeze the property taxes at 1977 levels for 4/5 of the tax base. But expenditures are not frozen. So growth can hurt counties and schools which depend heavily on property taxes. This means that it is necessary to look at the impacts over a 10 to 15 year period. Looking only at first year impacts can be misleading if the state has tax institutions like Ohio.

Little is known about the time frame of multiplier effects in the private sector. Input-output models assume an instanteous adjustment. Some economists question this view and yet little empirical research is available to describe how the lag effect works.[12]

Conclusion

Community can be defined in many ways and ought to be. There are overlapping groups affected by most developments. The appropriate definition of communities depends on the development, the decision-makers and their goals, and the scale of the development and degree of spillover to other groups and communities.

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11 Murdock and Leistritz, pp.

12 Morse and Hushak, pp.

Aggregate benefit-cost ratios for the entire community are likely to be misleading because each "community" may value the consequences of growth in differential fashions.

Development is used here to imply changes in natural resource rise. Impacts are defined as the consequences, either positive or negative, of development. These should be estimated by comparing the level of each goal with the development to the level without it. This with-without comparison is superior to the before-after approach.

Both direct and indirect linkages between economic sections must be considered to determine the magnitudes of impacts. Input-output and export base analysis provide two empirical alternatives for examining these linkages. Greater research effort is needed in identifying and quantifying the linkages between ecological, social and economic systems.

Community goals must be carefully considered before specifying relevant impacts. Important concerns for some groups and communities may be unimportant to others. Private sector benefits, particularly income benefits, are currently defined in several ways. The differences in these definitions need to be reconciled or clarified.

Estimates of public expenditure changes can be done in numerous ways. The relative merits and costs of each procedure has not yet been studied. Since they lead to widely varying results additional research is needed on this issue.

An Idea for Regional Research

There currently exists a large number of economic and fiscal impact models. The degree to which they consider the relevant variables and handle them in an appropriate fashion has not been examined or reported in the literature. The system does not provide rewards for analyzing the strengths and weaknesses of others' models. Institutional mechanisms have not existed for making improvements on a small section of anothers' existing model and simply transfering the remaining acceptable parts between states.

This lack of technical exchange has led to duplicative efforts in several states. Yet other states have not been able to allocate the resources to an independent development. There is a need to develop an institutional mechanism for critiquing, and modifying existing models and transfering these between states.

The costs and distribution of costs, the incentive systems for individual researchers and extension workers appear to be the obstacles to these suggestions. Research, probably by sociologists, may need to focus on the transfer problem itself as well as the required changes in economic demographic and social impact models.

REFERENCES

Clayton, Kenneth C., "The Community Economic Growth Impact Model," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Darling, David L., Jr., "The Indiana Experience with Growth Impact Models," Proceedingsof the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Doeksen, Gerald A., "Useful Community Service Research," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Hushak, Leroy J., "Definition and Estimation of Private Sector Benefits," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Leonfief, Wassily, "Quantitative Input-Output Relations in the Economic System of the United States," The Review of Economics and Statistics XVIII August 1936, pp. 105-25.

Lin, Wuu-Long, and Pan A. Yotopoulos, "The Utilization of Linkage Analysis in Development Planning," Currculum and Teaching Materials No. 45, ADC Teaching Forum, The Agricultural Development Council Inc., 630 Fifth Ave., New York 10020, April, 1975.

Leistrity, F. Larry and Steve H. Murdock, "Computerized Socioeconomic Impact Assessment Models: A Review and Evaluation of Methods and Applications," Dept. of Agricultural Economics, North Dakota State University, Memo, December 1979.

Morse, George, "With-without Perspectives in Growth Impact Models," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Morse, George W., "Estimates of the City of Athens' Additional Annual Expenditure with the Proposed Route 56 Annexation," Dept. of Agricultural Economics & Rural Sociology, The Ohio Agricultural Research and Development Center and The Ohio State University, ESO 530, October 1978.

Morse, George W. and John D. Gerard, "Economic Growth Impacts: A Technical Description of an Ohio Model for Rural Communities," Dept. of Agricultural Economics & Rural Sociology, The Ohio Agricultural Research and Development Center and The Ohio State University, memographed 1979.

Morse, George and Leroy Hushak, "Income and Fiscal Impacts of Manufacturing Plants in Southeast Ohio," Research Bulletin 1108, The Ohio Agricultural Research and Development Center and The Ohio State University, 1979.

Nelson, Glenn, "Distributional Issues in Community Growth Impact Models," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Shaffer, Ron, "Estimating Local Income Multipliers: A Review and Evaluation of the Techniques for Ex Ante Use," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.

Smith, Eldon D., "The Distribution of the Labor Supply for Community Economic Growth," Proceedings of the Ex Ante Growth Impacts Model Conference, North Central Regional Center for Rural Development, Ames, Iowa, October 1979.